Claims

1.

A method of measuring wall thickness of a transparent cylindrical container that comprises the steps of:

(a) moving the container transversely along a defined path while simultaneously rotating the container about its axis,

(b) directing onto the wall of the container, as it rotates and translates in said steps (a), a line-shaped light beam having a long dimension perpendicular to the axis of the container and parallel to the direction of translation of the container,

(c) directing onto a light sensor light energy reflected from portions of the outer and inner wall surfaces of the container that are perpendicular to light energy directed onto the container in said step (b), and

(d) measuring container wall thickness as a function of separation at said sensor between said light reflected from said outer and inner wall surfaces.

2.

The method set forth in claim 1 wherein said step (a) is accomplished by rolling the container along a rail.

3.

The method set forth in claim 2 wherein said rail is a linear rail.

4.

The method set forth in claim 3 wherein said containers are moved horizontally in said step (a) with their axes oriented vertically, and wherein said steps (b) and (c) are carried out in a vertical plane that is perpendicular to the direction of translation of said container in said steps (a).

5.

A method of measuring wall thickness of transparent cylindrical container that comprises the steps of:

(a) moving the containers transversely along a defined path and simultaneously rotating the containers about their central axes,

(b) directing light energy onto each container traveling in said path in a plane at an angle to the axis of the container such that a portion of the light energy is reflected from the outer surface of the container wall and a portion is refracted into the container wall and reflected from the inner wall surface,

(c) directing into a light sensor portions of the light energy reflected from the outer and inner wall surfaces along a light path coplanar with the incident light energy and with said axis, and

(d) measuring wall thickness of each container as a function of separation at said sensor between said light portions reflected from the inner and outer wall surfaces of the container.

6.

The method set forth in claim 5 wherein said step (c) comprises the steps of:

(c1) scanning said sensor at increments of container translation along said path, and

(c2) measuring wall thickness at angularly spaced positions around said container wall corresponding to said increments of container translation along said path.

7.

The method set forth in claim 6 wherein said step (b) comprises the step of directing said light energy continuously into each container as the container moves along said path.

8.

The method set forth in claim 6 wherein said step (a) comprises moving and simultaneously rotating multiple containers along said path, and wherein said step (b) comprises the step of directing said light energy onto each of the containers in sequence as the containers are moved and rotated along said path.

9.

Apparatus for measuring sidewall thickness of a container, which comprises:

a conveyor for moving the container transversely of its axis through an inspection station and simultaneously rotating the container about its axis,

a light source and an illumination lens system for directing onto the sidewall of the container, as it passes through said inspection station, a line-shaped light beam having a long dimension perpendicular to the axis of the container and parallel to the direction of movement of the container through the inspection station.

a light sensor and an imaging lens system for directing onto said sensor light energy reflected from portions of the outer and inner sidewall surfaces that are perpendicular to the illumination light energy, and

an information processor responsive to light energy directed onto said light sensor by said imaging lens system for determining thickness of the container between said outer and inner sidewall surfaces.

10.

The apparatus set forth in claim 9 wherein said illumination lens system directs said light beam continuously into each container as it moves through said inspection station.

11.

The apparatus set forth in claim 9 wherein said conveyor is constructed to move multiple containers through said inspection station in sequence, and wherein said illumination lens system includes a mirror and an actuator coupled to said mirror to direct said beam onto each container in sequence as the container moves through said inspection station.

12.

The apparatus set forth in claim 11 wherein said information processor is coupled to said actuator for selectively controlling direction of light energy onto the containers.

13.

The apparatus set forth in claim 9 further comprising an encoder coupled to said conveyor, said information processor being coupled to said encoder for scanning said sensor at increments of container motion through said inspection station.

14.

The apparatus set forth in claim 9 wherein said conveyor comprises a rail and a belt for rolling the container along said rail, said light source being disposed to direct light energy onto an external surface of the container adjacent to said rail.

15.

The apparatus set forth in claim 9 wherein said imaging lens system includes a fresnel lens having a focal point at said sensor.

16.

The apparatus set forth in claim 9 wherein said light source comprises a laser, and

wherein said illumination lens system comprises a cylinder lens for fanning the output of said laser into a flat beam having a divergence point at said cylinder lens, and a secondary illumination lens having a first focus at said divergence point and a second focus at the outer surface of the container.

17.

The apparatus set forth in claim 16 wherein said secondary lens includes a fresnel lens, a spherical lens, or a pair of cylinder lenses.

18.

The apparatus set forth in claim 9 wherein said light source comprises a laser, and wherein said illumination lens system comprises a spherical lens for focusing the output of said laser, a fresnel lens having a focus at the focus of said spherical lens, and a cylinder lens having a focus at the outer surface of the container.

19.

The apparatus set forth in claim 18 further comprising a mirror disposed at said focus of said spherical lens, and a motor coupled to said mirror for controlling direction of illumination light energy through said fresnel and spherical lenses.